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THE TAPEWORMS OF AMERICAN CHICKENS AND TURKEYS.

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THE TAPEWORMS OF AMERICAN CHICKENS AND TURKEYS.

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The important subject of tapeworms of poultry has received but little attention in this country. Only one extensive paper concerning these parasites has appeared in the United States, that of Stiles (1896), which is now out of print, and also somewhat out of date, especially in regard to American forms. This lack it is hoped will be supplied, in part at least, by the present article, which includes complete descriptions of all species of tapeworms now known to occur in chickens and turkeys in this country, with a key for their identification, and in addition the following preliminary remarks, taken from Stiles, in regard to life histories, prevention, treatment, etc.:

LIFE HISTORY AND SOURCE OF INFECTION.

The life history of a number of forms is known. (The life history of none of the forms so far reported in this country has yet been worked out.) So far as yet worked out, the larval stage is in every case a cysticercoid and lives in some invertebrate (snail, insect, crustacean, or worm). There are no grounds for believing that poultry can become infected with tapeworms directly from the eggs contained in the droppings.

The life history of these worms agrees with the life history of other tapeworms; the ova of the parasites are voided with the excrement and are swallowed by an intermediate host; the six-hooked embryo (known as an oncosphere) contained within the eggshell then bores its way from the intestine into the body cavity of the intermediate host (a worm, snail, crustacean, or insect) and develops into a larval form (known in this case as a cysticercoid). This larva develops into an adult worm when swallowed by a chicken, duck, goose, etc.

The known or supposed life history has been based upon four different methods of work, i. e.—

(1) Experimental infection of the fowls by feeding to them known larval stages found in invertebrates, and thus raising the adult stage.

(2) Experimental infection of invertebrates by feeding to them the eggs of tapeworms found in birds, and thus raising the larval stage.

(3) Comparison of the hooks upon the heads of adult tapeworms of birds with the hooks of larvæ found in invertebrates, and thus associating the young and the old stages.

(4) Wild speculation as to the intermediate hosts, based upon negative results and totally devoid of any scientific foundation.

Of these four methods of work, the first two give positive proof of the life history when the experiments are successful; the third gives a probability to the statements, but not a proof; the less said about the fourth method the better.

Chickens are known to become infected with one tapeworm [*Davainea proglottina*, not yet reported in this country] through eating slugs (*Limax*). They are supposed to become infected with a second [*Davainea echinobothrida*] through eating snails (*Helix*); by a third [*Choanotænia infundibuliformis*], through eating flies, and by a fourth [*Amœbotænia sphenoides*, not yet reported in this country] through eating earthworms.

Ducks are known to become infected with two worms through swallowing fresh-water crustaceans, and are supposed to become infected with three other tapeworms in the same way; another tapeworm is supposed to be transmitted to them through flies.

Geese are supposed to become infected with five species of tapeworms by swallowing small fresh-water crustaceans.

Nothing is known in regard to the source of infection of the tapeworms of pigeons and turkeys, but investigations in this field should be based upon the tapeworms of chickens.

THE RELATION OF THE TAPEWORMS OF WILD BIRDS TO THOSE OF THE DOMESTICATED FOWLS.

Only two of the chicken tapeworms have as yet been recorded for wild birds, but the majority of the tapeworms found in the domesticated ducks and geese are also recorded from closely allied wild birds. Besides these forms, however, many species have been described in wild birds which are not known to occur in the domesticated fowls. This renders the economic side of the question of avian cestodes extremely complicated and demands a thorough study of the parasites of wild birds in connection with those of our domesticated fowls.

SYMPTOMS AND PATHOLOGY.

From a standpoint of symptomatology practically nothing is known upon this subject. In general, however, it may be stated that aquatic birds are less affected by the presence of tapeworms than land birds, that young birds suffer more than old birds, and that, although a fowl may harbor a small number of tapeworms without showing any appreciable effects, a heavy infection injures the health and may result in death, as has been abundantly demonstrated by epidemics observed in different parts of the world. It has also been noticed that poultry are more severely infested in wet years than in dry years, and the general application may be made that poultry kept in damp places will be more heavily infested than fowls kept in dry places. All of these statements are general principles of parasitology.

Zürn (1882, p. 17) gives the symptoms as follows:

> If numerous tapeworms are present in the intestines of young or old fowls, a more or less extensive intestinal catarrh develops, corresponding to the greater or less number of parasites present.
>
> The intestinal catarrh shows itself, especially in chickens and geese, as follows: The sick animals become emaciated, although the appetite is not especially disturbed. At times the appetite is even increased. The droppings are thin, contain considerable yellow slime, and are passed in small quantities, but at short intervals. The poultry raiser must direct his attention to these thin, slimy, and often bloody droppings, for if any treatment against the tapeworms is to be undertaken this must be done as early as possible. In observing the droppings it should be noticed whether tapeworm segments or eggs are present. The eggs can be seen, of course, only with the microscope.

After a time other symptoms develop. The sick animals become dull and listless, remain apart from the rest of the flock, the feathers are ruffled, and the wings drop, the appetite is lost, and the birds allow themselves to be easily caught. Although it was stated that in the beginning of the trouble the appetite is not disturbed, the sick animals develop an intense thirst for cold water. When it rains, they run under the eaves in order to catch water, and in winter are eager for ice water.

At reading this, some experienced poultry raisers will probably reply that many chickens which are not sick are fond of very cold water. The droppings are also thicker or thinner according to the food. Both of these facts are known to me (Zürn). At the same time I look with suspicion of tapeworms upon every chicken which shows an especial thirst for cold water, and, as for the droppings, the fowls infected with tapeworms have droppings mixed with mucus and blood, and pass their excrements much oftener than other fowls do.

The intestinal catarrh often ends fatally.

Upon postmortem the body is seen to be thin and anemic. The intestine generally contains no food, the mucosa is soft and hyperæmic and covered with reddish yellow, more or less thick, purulent mucus. According to Hertwig, epileptic attacks are frequently noticed in chickens affected with intestinal worms.

The diagnosis by symptoms seems to me very uncertain, and although the symptoms described by Zürn serve as an indication of the disease they can not be taken as proof. The diagnosis by hunting in the droppings for segments of the parasite is less satisfactory than would be supposed, for it is not rare to find chickens badly infested with tapeworms when it has been impossible to discover segments in the manure. This method is rendered doubly uncertain because the color of the segments is about the same as the urine in the feces. Microscopic examination of the feces for eggs is quite a certain though not positive method for diagnosis of tapeworm disease of poultry, but it is thoroughly impracticable for the farmer to attempt it. The best method for the farmer to follow is to kill one of the sick chickens when he suspects tapeworms and to cut out the intestine; he should then open the intestinal tract from the gizzard to the anus, in a bowl of warm water, and look for the parasites.

TAPEWORM-INFECTED FOWLS AS FOOD.

None of the tapeworms of birds are transmissible to man in any stage of their development, and the presence of tapeworms in the intestine of fowls does not in itself warrant the condemnation of their bodies as an article of food.

PREVENTION.

From the nature of the intermediate hosts (fresh-water crustaceans) of the tapeworms of the aquatic birds it is evident that nothing can be done to prevent the introduction of larval tapeworms into ducks and geese, if these animals are allowed to visit ponds. Confining the animals to frequently flushed artificial tanks will, however, prevent tapeworm infection.

With chickens the outlook is somewhat better. An extermination of slugs will insure immunity against *Davainea proglottina*, but no precise directions can be given to prevent chickens from becoming infected with other tapeworms until the life history of these parasites is better understood. It will be well, however, to keep chickens housed in the morning until the sun is well up and the ground is dry, for they will thus be less likely to meet with the supposable intermediate hosts of other worms.

Absolutely nothing can be done at present looking to a prevention of the transmission of tapeworms of wild birds to the domesticated fowls through known or unknown intermediate hosts, except to prevent the domesticated ducks, geese, etc., from visiting ponds.

There is, however, considerable outlook for improvement if different kinds of fowls are alternated in succeeding years upon the same ground, or if the runs and yards of fowls are occasionally changed.

The safest plan to prevent the spread of poultry worms would be to destroy the manure from infected fowls. If one is not willing to do this, however, because of its commercial value, he should at least take steps to prevent further infection from it. If the sick chickens are confined to a comparatively small space, their droppings can easily be collected and placed in a strong barrel, to which the access of snails, slugs, worms, etc., should be guarded against. It is not known how long the eggs of poultry tapeworms will live, but it seems very doubtful to me whether they could live many months in such a barrel if placed in a dry spot. It seems almost certain that they could not live through the winter. The temperature required to kill the eggs has likewise not yet been determined, but probably 50° to 60° C. (122° to 140° F.) would suffice. Sulphuric acid (10 per cent) or quicklime is an excellent disinfectant for feces containing eggs of parasites.

The proper care of the manure from infected fowls is unquestionably the most important preventive measure against tapeworm disease.

TREATMENT.

The treatment of tapeworm disease in the domesticated fowls must for the present be more or less experimental, as the records in this line are extremely limited.

The first rule to be carried out in all cases of diseased animals, whether chickens, turkeys, geese, ducks, or others, is to isolate them from the rest of the flock and keep them confined until they have recovered. The second rule is to destroy the droppings of all animals known to be infected with parasites, or, if the manure is needed as fertilizer, it should be treated in such a manner so as to kill the ova. These two rules can be easily carried out, and if a poultry raiser or a stock raiser is not willing to set aside a small yard for the isolation of the sick animals, where their droppings can be easily collected and taken care of every day, it is almost useless for him to administer anthelmintics to his fowls or other animals.

The chief drugs used against tapeworms are extract of male fern, turpentine, powdered kamala, areca nut, pomegranate-root bark, pumpkin seeds, and sulphate of copper (bluestone).

Areca nut.—According to Zürn, powdered areca nut is the best tapeworm remedy for fowls, but he calls attention to the fact that turkeys are unfavorably affected by this medicine.

Zürn advises the administration of powdered areca nut in doses of 2 to 3 grams (= 30 to 45 grains) mixed with butter and made into pills.

Liquid extract of male fern is very effectual against tapeworms. Hutcheon advises a teaspoonful for young ostriches 3 to 4 months old, to a tablespoonful for a full-grown ostrich; it may be made into a pill with flour.

Turpentine may be given to ostriches in doses of a dessertspoonful for chicks 3 to 4 months old, to 2 tablespoonfuls for a full-grown bird; its action is much more effective when combined with a purgative, such as linseed or castor oil. (Hutcheon.)

As a safe rule, we can adopt 1 teaspoonful (about 4 c. c. = about one-eighth of an ounce) to 3 teaspoonfuls (about 12 c. c. = about three-eighths of an ounce) as the dose for chickens, the size of the dose being determined by the size of the chicken.

Powdered kamala.—Mégnin states that very good results followed the use of this drug, mixed with the food, against tapeworms of pheasants. Hutcheon advises for ostrich chicks 1 month old, 1 dram; 2 months old, 1½ drams; 3 to 4 months old, 2 drams; 18 months old, 1 ounce; a full-grown ostrich, 2 drams more. It does not require to be mixed with a purgative. Powdered kamala may be given mixed in a little milk or water or it may be made into pills with a little flour and water.

Pumpkin seeds.—These, according to Zürn, are not well borne by turkeys and not always by chickens, but it would be well to experiment further with them.

Pomegranate-root bark.—Very effective against tapeworms in ostriches, but must be given in large doses and followed by a purgative. (Hutcheon.)

Perroncito advises the following treatment for tapeworms in chickens (dose for one chicken):

(1) Aloes (socotrine or caballine), 15 to 20 centigrams. The animal is fasted the same day.

(2) Pumpkin seeds, 40 to 50. Administered to each chicken on the second day.

(3) Male fern, powdered, 100 grams. Mixed in bran.

All of the above medicines should be procured as fresh as possible. Many failures in treating for tapeworms are due to the fact that old drugs have been used which had lost their anthelmintic properties.

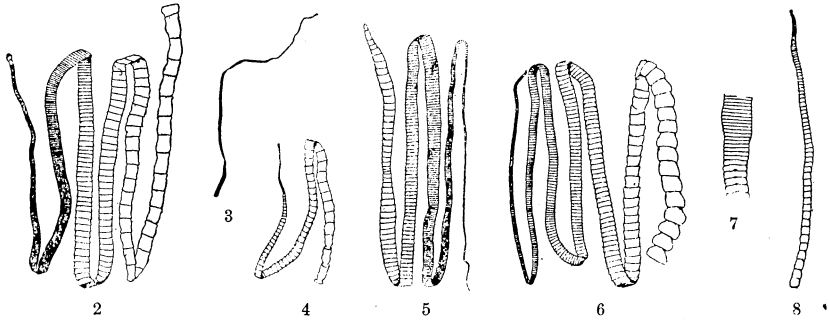


FIG. 2.—*Metroliasthes lucida.* Entire worm. Natural size. Original.
FIG. 3.—*Hymenolepis carioca.* Entire worm. Natural size. Original.
FIG. 4.—*Choanotænia infundibuliformis.* Entire worm. Natural size.
FIG. 5.—*Davainea tetragona.* Entire worm. Natural size. Original.
FIG. 6.—*Davainea echinobothrida.* Entire worm. Natural size. Original.
FIG. 7.—*Davainea echinobothrida.* Portion of posterior end showing openings between the segments. Natural size. Original.
FIG. 8.—*Davainea cesticillus.* Entire worm. Natural size. Original.

While there is little information available to add to the above discussion of treatment and prevention of tapeworm diseases in poultry, our knowledge of the species of poultry tapeworms found in this country has advanced somewhat, so that instead of only two species, as reported in Stiles's paper, there are six easily recognizable species now known to occur in American chickens and turkeys,[a] which may be identified by means of the following key:

[a] The tapeworms of American domesticated ducks, geese, and pigeons have as yet not been investigated.

Key for the identification of tapeworms occurring in chickens and turkeys in the United States.

1. Head unarmed 2
   Head armed 3
2. Maximum width of worm, 1.5 to 2.5 mm.; genital pores irregularly alternate; hindermost segments longer than broad and containing a single large spherical egg capsule ..... *Metroliasthes lucida.*
   Maximum width of strobila less than 1 mm.; genital pores unilateral on the right-hand margin of the strobila; all of the segments broader than long; eggs contained in a sac-like uterus which fills nearly the entire gravid segment ..... *Hymenolepis carioca.*
3. Rostellum armed with a single row of 16 to 20 hooks, 20μ to 30μ long, with long dorsal root and short ventral root ..... *Choanotænia infundibuliformis.*
   Rostellum armed with numerous small hooks, with short dorsal root and long ventral root 4
4. Suckers unarmed; eggs not grouped together in egg capsules; in the hindermost segments the uterus is broken up into numerous sacs, each of which contains a single egg; rostellum very broad (over half as broad as the head) and flat or hemispherical, armed with 400 to 500 instable hooks 7μ to 10μ long; neck very short; anterior segments nearly as broad as or more commonly broader than head ..... *Davainea cesticillus.*
   Suckers armed; eggs grouped together in numerous egg capsules 5
5. Rostellum armed with a crown of about 100 hooks, 6μ to 8μ long, arranged in a single row; hooks on suckers 3μ to 8μ long; genital pores unilateral, situated at or in front of the lateral margin of each segment; cirrus pouch pyriform, 75μ to 100μ long ..... *Davainea tetragona*
   Rostellum armed with a crown of about 200 hooks, 10μ to 13μ long, arranged in a double row; hooks on suckers, 6μ to 15μ long; genital pores, irregularly alternate or rarely almost entirely unilateral, situated posterior of the middle of the lateral margin of each segment; cirrus pouch, flask shaped, 130μ to 180μ long; causes the nodular disease of the intestines of chickens ..... *Davainea echinobothrida.*

Metroliasthes lucida RANSOM, 1900.

SYNONYMY: *Metroliasthes lucida* RANSOM, 1900, pp. 213–226, pl. 13, figs. 1–6; pl. 14, figs. 7–10.

SPECIFIC DIAGNOSIS: *Metroliasthes:* Length, 200 mm. or more. Width of strobila just behind the head, 0.6 mm.; greatest width, 1.5 to 2.5 mm. Most anterior segments five to six times as broad as long; posterior segments about twice as long (2.5 to 3 mm.) as broad (1.5 to 1.8 mm.). Head flattened dorsoventrally and broader than long, 0.75 mm. broad and 0.58 mm. long. Hooks and rostellum lacking. Suckers well developed, 0.2 to 0.25 mm. in diameter, situated somewhat anteriorly. Neck short, strobilation becoming apparent within a distance of 2 mm. behind the head. Posterior border of each segment prolonged into a short rim which overlaps slightly the anterior border of the following segment. Genital pores marginal and irregularly alternating, one pore in each segment located near the middle of the lateral margin in the younger segments; in older segments, posterior of the middle. Cirrus pouch and vagina are ventral of the dorsal excretory canal and dorsal of the longitudinal nerve and ventral excretory canal.

Male reproductive organs: Testicles 30μ to 100μ in diameter, 20 to 40 in number, arranged in a mass extending transversely across the posterior portion

of the segment between the excretory canals. Efferent canals from the testicles unite to form the vas deferens, which extends forward and forms a mass of coils in the anterior portion of the (young) segment at the base of the cirrus pouch.

Cirrus pouch cylindrical with the distal two-fifths considerably more slender than the proximal portion. Size in the sexually mature segment about 400μ long by 100μ in diameter in its proximal portion and 50μ in diameter in its distal portion. Protractile portion of vas deferens, or cirrus, about equal in length to the cirrus pouch, armed with long powerful spines.

Female sexual organs: Vagina comparatively straight, 6μ to 9μ in diameter; inner portion after copulation becomes swollen and functions as a seminal receptacle. Ovary in the middle of the proglottis posterior of the inner end of the cirrus pouch and anterior of the testes; when fully developed it is plump and rounded, with a convex, more or less lobulated, anterior surface and a concave posterior surface. Shell gland posterior of the ovary. Posterior of the shell gland is the yolk gland. Uterus at first a transverse cord of cells dorsal of the ovary and close behind its posterior edge; when fully developed consists of two prominent spherical sacs lying side by side in the posterior portion of the segment and filled with eggs. A cone-like, fibrous structure para-uterine organ develops in front of the uterus. The eggs in masses are pressed out of the uterus into the para-uterine organ, and the latter then becomes modified to form a capsule closely investing the eggs. This capsule, usually spherical in shape, is a very prominent structure in the segments of the posterior portion of the worm, occupying the middle of the segment in front of the genital pore. The encapsuled eggs are oval with three membranes, a thin inner membrane closely enveloping the embryo, or oncosphere; a thicker middle membrane, 55μ by 35μ in diameter, and a thin outer membrane 75μ by 50μ in diameter. The embryo is 30μ in diameter, and its hooks are 20μ to 25μ long.

LIFE HISTORY.—Unknown.

HOST.—Turkeys (*Meleagris gallopavo*); ? chickens (*Gallus domesticus*).

LOCATION.—Intestine.

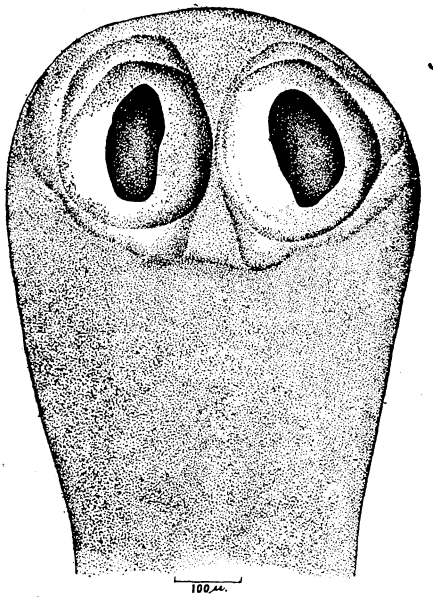
GEOGRAPHICAL DISTRIBUTION.—North America, Europe.

This species seems to be the most common tapeworm of turkeys in this country. It is readily recognized by its unarmed head and the prominent spherical egg capsule in the middle of each of the oldest segments. Its presence in chickens is doubtful.

Hymenolepis carioca (Magalhães, 1898) RANSOM, 1902.

SYNONYMY: [?] *Tænia exilis* DUJARDIN, 1845a, p. 602.—*Tænia tetragona* MOLIN, 1858, p. 139 (in part).—*Tænia* sp. Conard in STILES, 1896, pp. 59–60, pl. 21, figs. 275–276.—*Davainea carioca* MAGALHÃES, 1898, pp. 449–451, figs. 7–12.—*Tænia Conardi* ZÜRN, 1898, p. 460.—*Hymenolepis carioca* (Magalhães) RANSOM, 1902, pp. 151–158, pl. 23, figs. 1–7, pl. 24, figs. 8–10.

SPECIFIC DIAGNOSIS.—*Hymenolepis:* Length 30 to 80 mm. Breadth at neck 75μ to 150μ, at posterior end 500μ to 700μ. Segments three to five times or more broader than long throughout the strobila. Head flattened dorso-ventrally, 140μ to 160μ long, 150μ to 215μ wide, and 100μ to 140μ thick. Suckers shallow, 70μ to 90μ in diameter, unarmed. Rostellum, unarmed, in the retracted position 25μ to 40μ in diameter and 90μ to 100μ in length, with a small pocket opening to the exterior in its anterior portion. Unsegmented neck portion of strobila 0.6 to 1.5 mm. long. Genital pores almost entirely unilateral, a single pore being located in each segment slightly in front of the middle of its right-hand margin.



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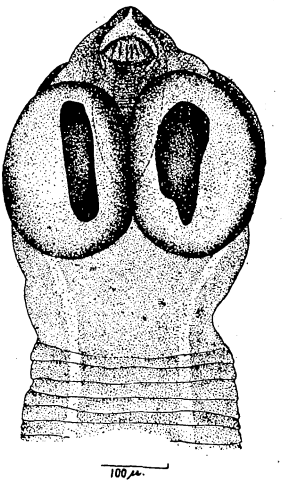

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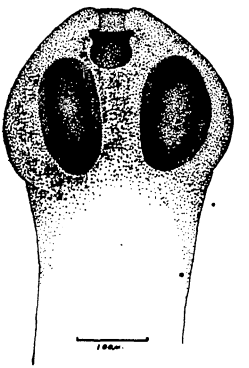

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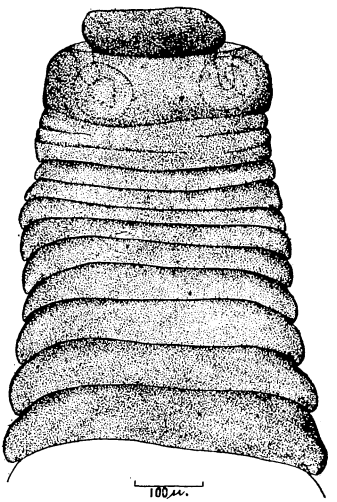

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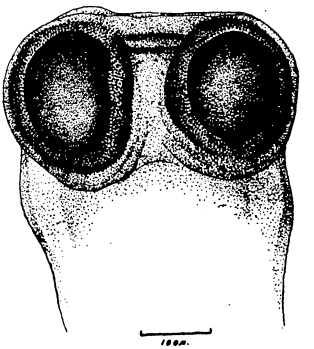

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FIG. 9.—*Metroliasthes lucida.* Head. Enlarged. Original.
FIG. 10.—*Hymenolepis carioca.* Head. Enlarged. After Ransom, 1902, Pl. 24, Fig. 8.
FIG. 11.—*Choanotænia infundibuliformis.* Head. Enlarged. Original.
FIG. 12.—*Davainea tetragona.* Head. Enlarged. Original.
FIG. 13.—*Davainea echinobothrida.* Head. Enlarged. Original.
FIG. 14.—*Davainea cesticillus.* Head and anterior portion of strobila. Enlarged. Original.

Male reproductive organs: Testicles three in number, normally two on the left and one on the right of the median line. On the dorsal side of the inner end of the cirrus pouch the vas deferens is swollen into a prominent seminal vesicle, which may attain a size of 70μ by 50μ. Cirrus pouch in sexually mature segments 120μ to 175μ long by 15μ to 18μ in diameter; almost cylindrical, slightly curved toward the ventral surface of the segment; on the outer surface about 20 longitudinal muscle bands 2μ to 3μ in thickness, very prominent in cross section; vas deferens enlarged within the cirrus pouch to form a small seminal reservoir occupying the proximal two-thirds of the pouch; the distal third of the portion of the vas deferens within the pouch is very slender, about 1μ in diameter and functions as a cirrus. Genital cloaca 12μ to 36μ deep.

Female reproductive organs: Opening of the vagina in the floor of the genital cloaca, ventral and posterior of the cirrus opening. First portion of vagina very narrow, 1μ in diameter. A small vaginal sphincter 8μ to 10μ from the vaginal opening. On the inner side of the sphincter the vagina gradually increases in diameter, and in sexually mature segments is swollen out into a prominent seminal receptacle which extends forward to the anterior border of the segment and inward a considerable distance beyond the proximal end of the cirrus pouch. Ovary faintly bilobed or trilobed in the posterior half of the proglottis, extending nearly across the segment when fully developed. Yolk gland spherical or ovoid, 30μ to 40μ in diameter, situated near the median line of the segment, and posterior and dorsal of the ovary. Uterus at first a solid cord of cells extending transversely across the segment along the anterior border of the ovary; becomes hollowed out and grows backward on the dorsal side of the ovary; in gravid segments occupies nearly the entire segment and is filled with eggs. Eggs in gravid uterus spherical or oval, with four thin membranes, the two middle membranes often approximated to form a single membrane; diameter of outer membrane 36μ by 36μ to 75μ by 70μ, of outer middle membrane 30μ by 30μ to 65μ by 60μ, of inner middle membrane 26μ by 26μ to 40μ by 35μ, of inner membrane 24μ by 16μ to 29μ by 21μ, of oncosphere 18μ by 14μ to 27μ by 19μ; length of embryonal hooks, 10μ to 12μ.

LIFE HISTORY.—Unknown.

HOST.—Chickens (*Gallus domesticus*).

LOCATION.—Small intestine.

GEOGRAPHICAL DISTRIBUTION.—North and South America, Europe.

Hymenolepis carioca is readily recognizable on account of its very slender and almost threadlike form. It is very difficult to obtain complete specimens on account of the delicacy and fragility of the worm, and the head is commonly broken off and lost. Several thousand individuals of this species are sometimes found in a single chicken, and in such cases the health of the fowl is likely to be very seriously affected. The writer has seen one instance in which the entire small intestine from beginning to end was filled and completely occluded by a mass of these worms.

Choanotænia infundibuliformis (Goeze, 1782) RAILLIET, 1896.

SYNONYMY.—[?] *Globus stercoreus* SCOPOLI (1772), p. 127.—[?] *Tænia infundibulum* BLOCH (1779a), p. 555, pl. 12, figs. 3–5 [probably in part synonymous with *T. infundibuliformis* Goeze].—[?] *Tænia avium* PALLAS, 1781, p. 87, pl. 3, figs. 29, 30.—[?] *Tænia articulis convideis* [misprint for *conoideis*, cf. Bloch, 1782, table of contents] BLOCH, 1782a, pp. 13–14, pl. 3, figs. 1, 2 [probably in part synonymous with *T. infundibuliformis* Goeze].—*Tænia infundibuliformis* GOEZE, 1782a, pp. 386–391, pl. 31A, figs. 1–6.—*Tænia cuneata* BATSCH, 1786a, p. 190,

figs. 117, 118.—[?] *Tænia conoidea* SCHRANK, 1788, p. 45 [*Tænia articulis conoideis* ,Bloch renamed].—[?] *Tænia serrata* ROSA, 1794 [not *T. serrata* Goeze, 1782].—*Alyselminthus infundibuliformis* (Goeze) ZEDER, 1800, pp. 271–274.—*Halysis infundibuliformis* (Goeze) ZEDER, 1803, pp. 345–347.—*Drepanidotænia infundibuliformis* (Goeze) RAILLIET, 1893, p. 302.—*Choanotænia infundibuliformis* (Goeze) RAILLIET, 1896, p. 159.—*Choanotænia infundibulum* (Bloch) COHN, 1899c, p. 421.—*Monopylidium infundibuliformis* (Goeze) CLERC, 1903, pp. 354–356, pl. 11, figs. 72, 74–76, 83.

SPECIFIC DIAGNOSIS.—*Choanotænia:* Length, 20 to 200 mm. or more. Head small, rounded or conoidal, about 0.4 mm. wide. Rostellum 65μ to 90μ wide, armed with a single row of 16 to 20 hooks 20μ to 30μ long, with long dorsal root and short ventral root. Suckers prominent, in preserved specimens elongated antero-posteriorly, major diameter up to 250μ. Short unsegmented neck region somewhat narrower than the head. Anterior segments very short, the following funnel shaped, much narrower at their anterior border than at their posterior border, posterior segments 1.5 to 3 mm. wide and nearly as long or somewhat longer, according to state of contraction, with convex lateral borders, and nearly as wide at the anterior border as at the posterior border. Genital pores irregularly alternating, situated one in each segment in the anterior third of the lateral margin, usually under cover of the backward projecting posterior border of the preceding segment. Vas deferens and vagina pass between the excretory canals and dorsal of the nerve.

Male reproductive organs: Testicles 25 to 40, massed in the posterior half of the segment. The vas deferens passes forward and in the anterior third of the segment forms a mass of coils which extends from the median line outward to the base of the cirrus pouch. Cirrus pouch globular, 75μ to 95μ in diameter. The portion of the vas deferens within the cirrus pouch is somewhat coiled. Cirrus 55μ to 70μ long, armed with long spines; outer surface of cirrus pouch forming the base of the deep genital cloaca also armed with spines.

Female reproductive organs: Vaginal opening in the genital cloaca posterior of the cirrus pouch. Vagina lies posterior of the cirrus pouch, and after crossing the ventral excretory canal is dilated to form an elongated seminal receptacle posterior and ventral with respect to the vas deferens, and extending to the well-developed shell gland, 40μ to 50μ in diameter, located at about the middle of the segment. The transversely elongated ovary occupies the anterior portion of the middle field of the segment in front of the testes, extending, when fully developed, nearly to the excretory canals on each side. Posterior of the ovary and shell gland, and ventral of the latter, is the large yolk gland, somewhat elongated transversely, with convex ventral surface and concave dorsal surface. The gravid uterus fills most of the segment, extending beyond the excretory canals on each side.

Eggs oval, with a very thin membrane next the embryo, followed by a rather thick smooth membrane 40μ by 32μ to 45μ by 36μ in diameter, and one or two outer membranes, very thin and wrinkled in preserved material. Diameter of outer membrane 65μ by 40μ to 60μ by 45μ; at each pole of the outer membrane a delicate appendage. Embryonal hooks 18μ long; embryo 32μ by 22μ in diameter.

LIFE HISTORY.—? Intermediate stage in the common house fly.

HOSTS.—Chickens (*Gallus domesticus*); migratory quail (*Coturnix coturnix*).

LOCATION.—Small intestine.

GEOGRAPHICAL DISTRIBUTION.—Europe, Africa, North and South America.

Tapeworms from ducks and pigeons have been assigned to this species, but its presence in these hosts is open to question. Cysticer-

coids showing many of the characters of the adult tapeworm head have been found in flies, but it has not been determined experimentally whether or not these cysticercoids represent a stage in the life history.

Davainea tetragona (Molin, 1858) BLANCHARD, 1891.

SYNONYMY.—*Tænia tetragona* MOLIN, 1858, p. 139.—*Davainea tetragona* (Molin) BLANCHARD, 1891t, p. 436, fig. 15 [in part].—*Tænia botrioplitis* Piana of FILIPPI, 1892a, pp. 75–78, pl. 1, figs. 1–4 [misdetermination].—*Tænia bothrioplitis* Piana of FILIPPI, 1892c, pp. 249–294, pls. 1–10 [misdetermination].—*Davainaea tetragona* (Molin) DIAMARE, 1898a, pp. 480–483 [misprint].—[?] *Davainea paraechinobothrida* MAGALHÃES, 1898, pp. 443, 444.

SPECIFIC DIAGNOSIS.—*Davainea:* 10 to 250 mm. long by 1 to 4 mm. broad, these dimensions varying with age and state of contraction. Head 175μ to 350μ in diameter, with retractile rostellum 50μ to 70μ in diameter, armed with a crown of about 100 hooks arranged in a single row. Suckers oval, 50μ to 90μ in diameter, armed with 8 to 10 rows of hooks. Rostellar hooks 6μ to 8μ long through longest axis, hammer shaped, with long ventral root and short dorsal root, prong short and recurved. Acetabular hooks of various sizes, from 3μ to 8μ, measured through longest axis, with long, thorn-like prong, dorsal root very short, ventral root longer than dorsal root, but shorter than prong. Neck usually long and slender. Segments trapezoidal and imbricate, edge of strobila serrate. Ultimate segments usually longer than broad, bell shaped. Genital pores unilateral, situated one in each segment, at or in front of the middle of the lateral margin, frequently marked by a papilla. Male and female canals pass on the dorsal side of the nerve and excretory vessels.

Male genitalia: Testes 20 to 30 in median field surrounding the female glands, most of them lying on the aporose side of the latter. Vas deferens lies in anterior third of segment, begins near the median line, and extends in a much convoluted course laterally to the base of the cirrus pouch, which it enters and, after a few coils in the basal portion of the latter, becomes transformed into the cirrus. Cirrus pouch pyriform, 75μ to 100μ in length. Basal portion surrounded by a prominent layer of longitudinal muscular fibers, neck with a thick layer of transverse fibers. Cirrus without apparent spines.

Female genitalia: Ovary in middle of segment. Yolk gland posterior of ovary, irregularly reniform, slightly longer in its transverse axis, about 100μ in diameter. Shell gland prominent, 50μ in diameter, immediately in front of yolk gland. Vagina begins at the genital pore posterior of opening of cirrus pouch, at first very slender but at a distance of 15μ to 25μ swells out into a thin-walled tube, functioning as a seminal receptacle, which extends transversely across the segment and joins the oviduct on the dorsal side of the ovary near the median line. The oviduct, after being joined in the shell gland by the vitelloduct, proceeds forward and ends on the dorsal side of the ovary. A definite and persistent uterus is not developed. The eggs as they pass from the distal end of the oviduct become embedded in a fibrous and granular mass, which gradually fills up most of the segment. This mass divides into 50 to 100 portions to form egg capsules, each surrounded by a membrane and containing 6 to 12 or more eggs. The egg is surrounded by three envelopes—an inner, close to the onchosphere; a middle, folded; and a smooth outer envelope. The onchosphere measures 10μ to 14μ in diameter; the outer envelope from 25μ to 50μ.

LIFE HISTORY.—Unknown.

HOST.—Chickens (*Gallus domesticus*).

GEOGRAPHICAL DISTRIBUTION.—Europe, Asia, North and South America.

Anatomically this worm is very closely related to the next following species, *D. echinobothrida*, but it lacks the peculiar pathological effects of the latter, which produces a nodular disease of the intestine with lesions much resembling those of tuberculosis.

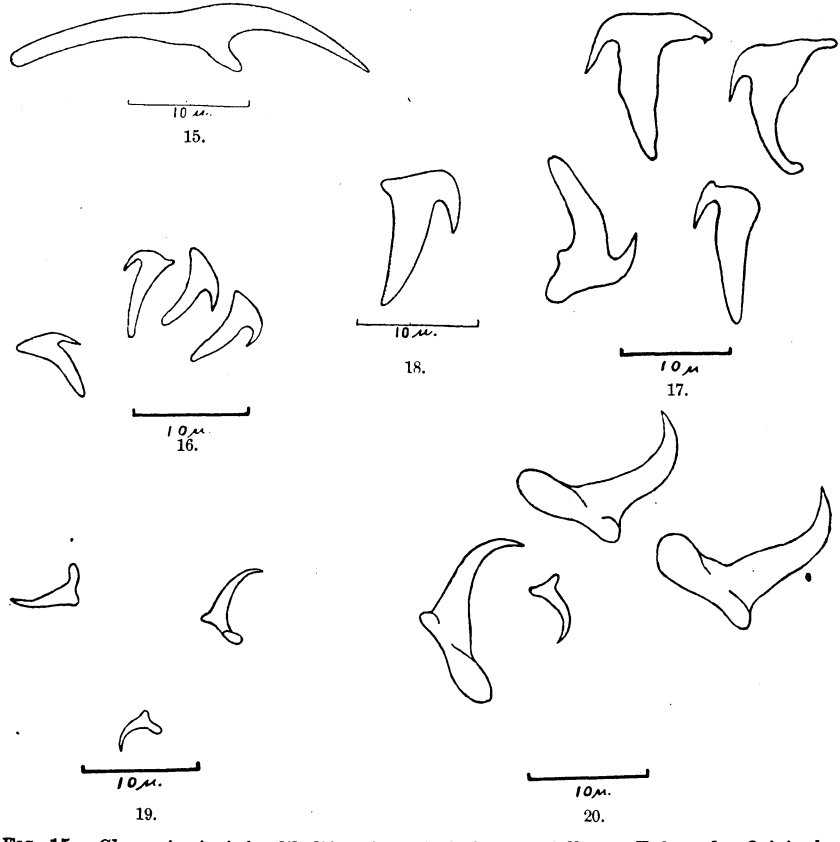


FIG. 15.—*Choanotænia infundibuliformis*. Hook from rostellum. Enlarged. Original.
FIG. 16.—*Davainea tetragona*. Hooks from rostellum. Enlarged. Original.
FIG. 17.—*Davainea echinobothrida*. Hooks from rostellum. Enlarged. Original.
FIG. 18.—*Davainea cesticillus*. Hook from rostellum. Enlarged. Original.
FIG. 19.—*Davainea tetragona*. Hooks from suckers. Enlarged. Original.
FIG. 20.—*Davainea echinobothrida*. Hooks from suckers. Enlarged. Original.

Davainea echinobothrida (Mégnin, 1880), BLANCHARD, 1891.

SYNONYMY.—*Tænia infundibuliformis* of MÉGNIN, 1880, pp. 395, 396 [in part].—*Tænia echinobothrida* MÉGNIN, 1880, pp. 119, 120.—*Tænia echinobotrida* MÉGNIN, 1881, p. 44 [misprint].—*Tænia botrioplites* PIANA, 1881, pp. 84–85.—*Tænia botrioplitis* PIANA, 1882, pp. 387–395, 1 pl.—*Tænia tetragona* Molin of KRABBE, 1882, pp. 361–362, pl. 2, figs. 55–60 [in part].—*Tænia bothrioplitis* RAILLIET, 1886, p. 267 [orthographic emendation of *T. botrioplitis* Piana].—*Tenia* [sic] *botrioplitis* (Piana) PERRONCITO, 1886, p. 245.—*Davainea echinobothrida* (Mégnin) BLANCHARD, 1891t, p. 433, fig. 9.—*Davainea tetragona* (Molin) of BLANCHARD, 1891t, p. 436, fig. 15 [in part].—*Tænia bothrioplites* BLANCHARD, 1891t, p. 436 [orthographic emendation of *T. botrioplites* Piana].—*Tænia botryoplitis* DOLLEY, 1894a, p. 1013 [misprint].—[*Tænia*] *botriophilitis* SCAGLIOSI, 1896, p. 539 [misprint].—*Davainea bothrioplitis* (Piana) MAGALHÃES, 1898, pp.

442, 443, 444.—[?] *Davainea paraechinobothrida* MAGALHÃES, 1898, pp. 443, 444.—*Tænia tetragona botrioplitis* PERRONCITO [? 1901], p. 268 [as a variety of *T. tetragona* Molin].

SPECIFIC DIAGNOSIS.—*Davainea:* Length, up to 250 mm.; width, 1 to 4 mm. Head, 250μ to 450μ in diameter, with retractile rostellum 100μ to 150μ in diameter, armed with a crown of about 200 hooks arranged in two ranks. Suckers round or oval, 90μ to 200μ in diameter, armed with 8 to 10 rows of hooks. Rostellar hooks similar in type to those of *D. tetragona*, but larger, measuring 10μ to 13μ in length. Acetabular hooks likewise similar to those of *D. tetragona*, but also larger, the largest measuring from 12μ to 15μ over all and the smallest 6μ. Neck generally thicker and shorter than that of *D. tetragona*, frequently equal in width to the head. Strobila resembling that of *tetragona*, but with serrate border more pronounced. Ultimate segments in preserved specimens differ also from those of *tetragona*, being less elongate and frequently marked by a median constriction. Owing to this constriction the adjacent borders of the most posterior segments pull apart in the median line and remain joined only toward the sides, giving rise to a median series of openings through the posterior portion of the strobila. Genital pores irregularly alternate, or sometimes almost entirely unilateral, situated one in each segment posterior of the middle of the lateral margin. Male and female canals pass on the dorsal side of the nerve and excretory vessels.

Male genitalia: Testes 20 to 30, arranged in median field as in *tetragona*. Vas deferens similar to that of *tetragona*. Cirrus pouch flask-shaped, 130μ to 180μ in length. Basal portion globular or ovoid, surrounded by a thick layer (10μ) of longitudinal muscle fibers, inside of which is a thick layer (15μ to 20μ) of transverse fibers. Neck of pouch measures 50μ to 75μ in length by 15μ to 20μ in diameter, surrounded by a layer of transverse fibers, thickened at the distal end of the pouch to form a sphincter. According to Mégnin, the cirrus is armed with minute spines.

Female genitalia.—Female organs as in *D. tetragona*. Eggs similar in size and structure.

LIFE HISTORY.—Unknown. According to Piana (1882) its supposed larva occurs in snails.

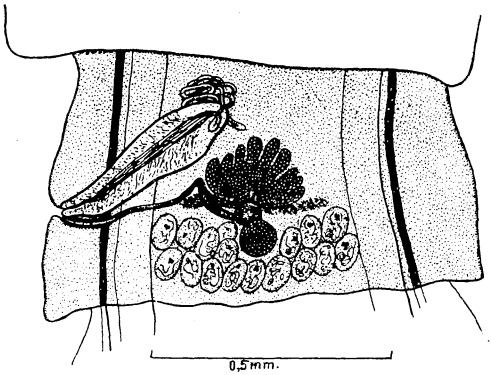
HOST.—Chickens (*Gallus domesticus*).

GEOGRAPHICAL DISTRIBUTION.—Europe, Asia, Africa (Pasquale, 1890), North and South America.

Davainea echinobothrida and the preceding species (*D. tetragona*) have been frequently confused on account of their great similarity in appearance.

D. echinobothrida, however, when fully matured is generally somewhat larger. The head, rostellum, suckers, hooks, and cirrus pouch are larger, the rostellar hooks are more numerous, the neck is shorter and thicker, and the genital pores are usually irregularly alternate, and situated in the posterior portion of the segments, those of *D. tetragona* being unilateral and situated at or in front of the middle of the segments.

An important characteristic of *D. echinobothrida* is the nodular disease of the intestine which it causes, a condition liable to be mistaken for tuberculosis. This disease was first recorded in the United States by Moore (1895), from whose article the following extracts are made.



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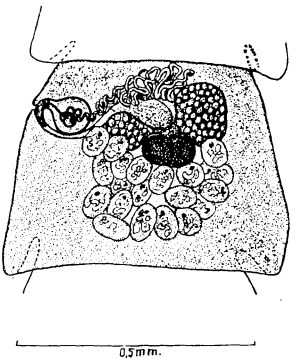

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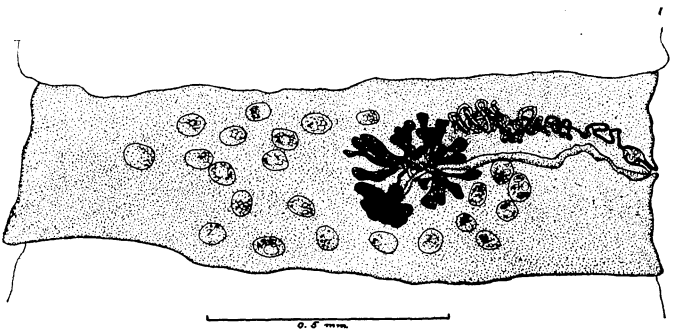

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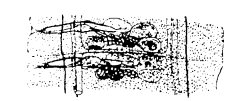

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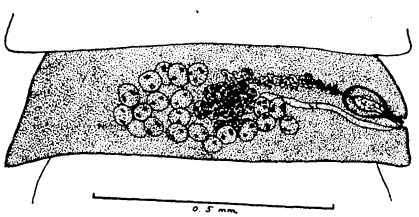

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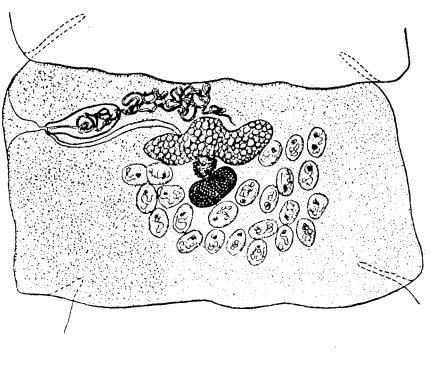

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FIG. 21.—*Metroliasthes lucida.* Segment showing the reproductive organs, ventral excretory canals, and lateral nerves. Enlarged. Original.

FIG. 22.—*Hymenolepis carioca.* Segments showing reproductive organs, excretory canals, and nerves. Enlarged. After Ransom, 1902, pl. 23, fig. 1.

FIG. 23.—*Choanotænia infundibuliformis.* Segment showing reproductive organs. Enlarged. Original.

FIG. 24.—*Davainea tetragona.* Segment showing the reproductive organs. Enlarged. Original.

FIG. 25.—*Davainea echinobothrida.* Segment showing the reproductive organs. Enlarged. Original.

FIG. 26.—*Davainea cesticillus.* Segment showing reproductive organs. Enlarged. Original.

The nodules were invariably more numerous in the lowest third of the small intestine. They occasionally appeared, however, in small numbers in both the duodenum and colon. The larger and to all appearances older nodules were found in the ileum near the ceca.

In the badly affected portion the nodules gave the appearance of closely set protuberances, varying in size from barely perceptible areas of elevation to bodies 4 mm. ($\frac{1}{6}$ inch) in diameter. In some instances they appeared to overlap one another. When separated by a band of normal tissue they were round or somewhat lenticular in form. In the latter case the long diameter was usually transverse to the long axis of the intestine. The larger nodules were of a pale or dark-yellowish color, while the smaller ones varied in shade from the more highly colored areas to the neutral gray of the normal serosa. To the touch they gave the sensation that would be expected if the subserous and muscular coats were closely studded with small, oval, solid bodies. The mucosa presented similar elevations. Attached to the mucosa over the nodules were a number of tapeworms. There were also in the more advanced cases a variable number of small (0.5 to 1 mm.) areas over the larger nodules in which the mucosa had sloughed, leaving small ulcerated depressions.

The larger nodules contained a greenish-yellow necrotic substance, which appeared in the advanced stages as a sequestrum with a roughened surface. On section it has a glistening, homogeneous appearance. Surrounding the necrotic substance was a thin layer of infiltrated tissue. The smaller nodules contained a more purulent-like substance and the smallest appeared to the naked eye as areas of infiltration. Sections of the affected intestine showed upon microscopic examination that the heads of the tapeworms had penetrated the mucous membrane and were situated in different layers of the intestinal wall. They were frequently observed between villi. As would be expected, the heads were not readily detected in the necrotic masses contained in the larger nodules, but were almost invariably seen in the smaller ones. In a few sections the tapeworm could be traced through the mucosa to the nodule in the muscular tissue in which its head appeared. In the earlier stage of the nodular development there is a cell infiltration about the head of the worm. This process continues until the infiltrated tissue reaches a considerable size.

The worms attached to the mucosa were usually small. A larger form was commonly found in the intestinal contents. Although macroscopically they appeared to be different, Doctor Stiles found that they were presumably of the same species.

ECONOMIC IMPORTANCE.—The importance of this disease is much greater than it at first appears, as the close resemblance of the nodules to those of tuberculosis renders it of much significance from a differential standpoint. As the intestines are stated to be frequently the seat of the specific lesions of tuberculosis in fowls, it is of the greatest importance that a thorough examination be made before a positive diagnosis is pronounced. There are already several statements concerning the presence of tuberculosis in fowls in which the data given are not sufficient to differentiate the disease from the one here described. A somewhat analogous disease of sheep caused by a nematoid (*Œsophagostoma columbianum* Curtice) has led to the deliberate destruction of many animals, the owners believing that tuberculosis was being eliminated from their flocks.

As the inquiry into the cause of poultry diseases becomes more general it is probable that this affection will be occasionally encountered, and unless its nature is recognized it may in some instances, like the sheep disease, lead to an unwarranted destruction of property.

In addition to its importance in differentiating tuberculosis it is in itself a malady worthy of careful attention. The fact that it has already appeared in

two flocks in the District of Columbia, and also in the States of North Carolina and Virginia, shows that the infesting cestode is quite widely distributed in this country. It is highly probable that the total loss it occasions, both from deaths and from the shrinkage of poultry products, due to the chronic course of the disease it produces, is very large.

DIAGNOSIS.—Tuberculosis is, as before stated, the only known disease for which this affection is liable to be mistaken, and it is of much importance that the two diseases should not be confounded. The diagnosis has not in my experience been difficult, as in every case the attached tapeworms were readily detected upon a close examination of the intestinal contents or of the mucous membrane of the infected portion of the intestine. However, the worms are quite small and could easily be overlooked in a hurried or cursory examination. In case of doubt, if the affected intestine is opened and the mucous surface washed carefully in a gentle stream of water, the small worms will be observed hanging to the mucous membrane. This discovery, in the absence of lesions in the liver or other organs, would warrant the diagnosis of the tapeworm disease. Although much is written concerning tuberculosis in fowls, especially in Europe, the investigations of poultry disease by this Bureau have thus far shown that it is not common among fowls in this country.

Davainea cesticillus (Molin, 1858) BLANCHARD, 1891.

SYNONYMY.—*Tænia infundibuliformis* Goeze of DUJARDIN, 1845, pp. 586–587, pl. 9, fig. A [misdetermination].—*Tænia cesticillus* MOLIN, 1858, p. 139.—*Davainea cesticillus* (Molin) BLANCHARD, 1891t, p. 434, fig. 11.

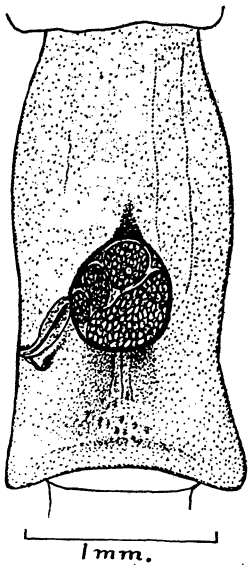
SPECIFIC DIAGNOSIS.—*Davainea:* Length, 10 to 100 mm. Maximum width, 1.5 to 3 mm. Head cylindrical, sometimes spheroidal, 0.3 to 0.6 mm. wide and 0.2 to 0.4 mm. long. Suckers unarmed, about 0.1 mm. in diameter. Rostellum broad and flat or hemispherical, 0.25 to 0.35 mm. wide, armed with a crown of 400 to 500[a] hooks, which are very instable and easily lost, arranged in two ranks. Hooks 8μ to 10μ long, with short dorsal root and long ventral root. Neck very short. Anterior segments three to five times as broad as long; the following increase in size until they become equal in length and breadth and finally even longer than broad; borders overlapping. Genital pores irregularly alternate, one in each segment, somewhat in front of the middle of the lateral margin in young segments and nearer the middle in older segments. Vagina and cirrus pouch pass dorsal of the two excretory canals and nerve.

Male reproductive organs: Testes, 20 to 30 in the posterior portion of the segment. Vas deferens much coiled before entering the base of the cirrus pouch, also coiled within the latter. Cirrus pouch ellipsoidal, 120μ to 150μ long by 55μ to 70μ wide. Cirrus when protracted, 10μ in diameter, armed with minute spines, and with a bulbous enlargement 20μ in diameter at its base, where it becomes continuous with the cirrus pouch; length when fully protracted, 150μ.

Female reproductive organs: Vagina is enlarged before reaching the median line into a small seminal receptacle. Ovary occupies the middle field in front of the testes. Yolk gland and shell gland posterior of the ovary, ventral and dorsal, respectively, in relative position.

Uterus develops at first in front of the ovary; gradually increasing in size, it finally occupies most of the segment and frequently extends laterally beyond the excretory canals. In the oldest segments it becomes divided into compartments or capsules each containing a single egg. Embryo, 36μ by 27μ in diame-

[a] Other authors state about 200, but apparently have underestimated the number.



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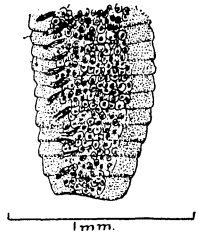

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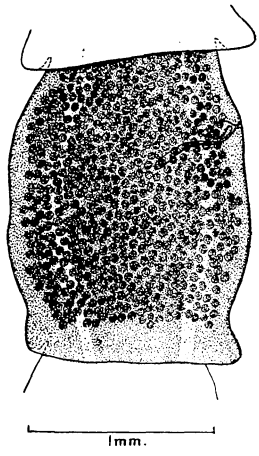

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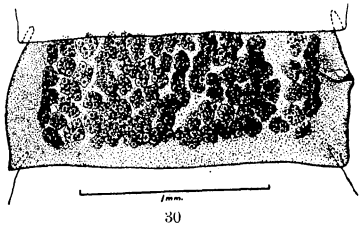

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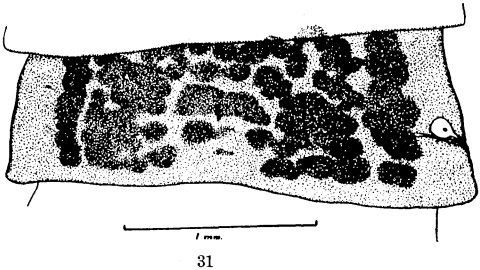

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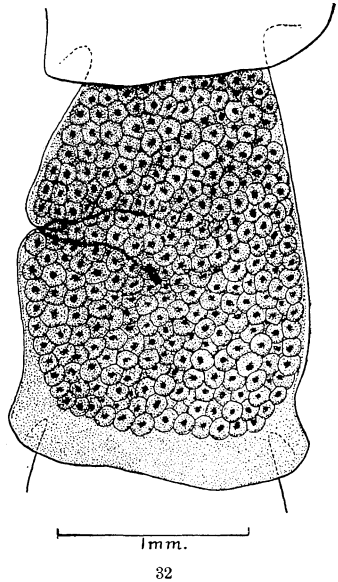

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FIG. 27.—*Metroliasthes lucida.* Gravid segment. Enlarged. After Ransom, 1900, pl. 14, fig. 7.

FIG. 28.—*Hymenolepis carioca.* Gravid segments. Enlarged. After Ransom, 1902, pl. 24, fig. 9.

FIG. 29.—*Choanotænia infundibuliformis.* Gravid segment. Enlarged. Original.

FIG. 30.—*Davainea tetragona.* Gravid segment. Enlarged. Original

FIG. 31.—*Davainea echinobothrida.* Gravid segment. Enlarged. Original.

FIG. 32.—*Davainea cesticillus.* Gravid segment. Enlarged. Original.

ter, with a very thin membrane closely adherent to its surface. The embryo is further enveloped by a thicker smooth membrane, oval in shape, 45μ by 40μ in diameter, with a filament at each pole attaching to a thin outer wrinkled membrane about 65μ by 50μ in diameter, and finally the egg is surrounded by a capsule composed of an outer and inner membrane, the latter closely adherent to or fused with the outer egg membrane and the former more or less widely separated from the latter and connected with it by a number of septa.

LIFE HISTORY.—Unknown.

HOSTS.—Chickens (*Gallus domesticus*), turkeys (*Meleagris gallopavo*).

LOCATION.—Small intestine.

GEOGRAPHICAL DISTRIBUTION.—Europe, Asia, Africa, North and South America.

The principal points among the details given in the diagnosis by which this species may be most readily identified are the head, with its broad, flat rostellum, the width of the most anterior segments usually greater than that of the head, and the eggs distributed in individual egg capsules in the posterior segments of mature worms.

O